STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

GRAVITY BASE STATION NETWORK IN ILLINOIS

Lyle D. McGinnis

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ABSTRACT

A gravity base station network comprising 29 stations has been established with a LaCoste and Romberg gravity meter in Illinois. The stations are tied to a pendulum base at Washington University, St. Louis, Missouri, having a value of 979.99863 gals. From a series of adjusted loops, the observed gravity value at the Champaign-Urbana, Illinois, base (Station 17) was found to be 980.12905 gals. All stations in the network are tied to within ±0.1 milligals of the St. Louis base.

INTRODUCTION

During the summer of 1965, 29 gravity base stations (fig. 1) were established in or near Illinois with a LaCoste and Romberg geodetic gravimeter (G-4) on loan from the United States Army Map Service, Gravity Division. The observations were made by members of the Illinois State Geological Survey to provide a common gravity base for state-wide regional surveys. Although a number of base stations had been established in Illinois prior to this work (see Behrendt and Woollard, 1961), it proved necessary to develop a network of internally consistent points to which regional surveys in the state could be tied. Regional gravity coverage on approximately one-mile grids is nearly half completed (fig. 2).

Stations in the regional surveys are occupied at bench marks and section corners located on U. S. Geological Survey topographic maps, where elevations are listed. Because of various limitations (Heigold et al., 1964), regional Bouguer data have an internal accuracy of ±0.2 milligals. Gravity data published in Illinois up to the time of the present paper have not been tied to a common base; thus corrections are necessary in comparing one area with another. Those reports published in the future will be tied to the present network. When finished, the regional surveys will furnish aids to geologic interpretations throughout the state.

The meter used in the gravity-control network has an extremely low and nearly linear drift rate (fig. 3) with a high reading precision of ±5 microgals. Resetting was not required with the instrument since it has a 6000-milligal range,
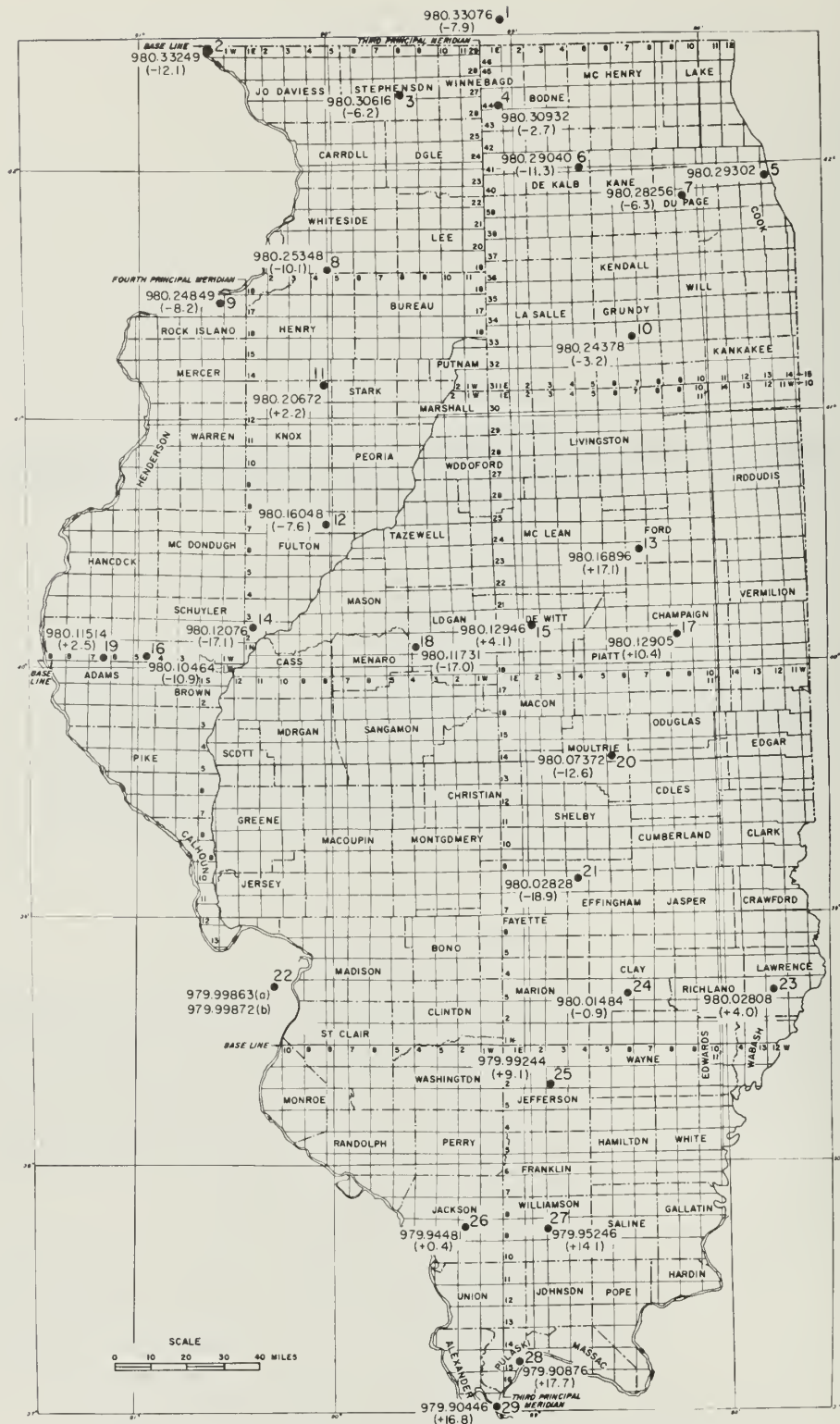
Figure 1. Locations of gravity base stations in Illinois showing station numbers, observed
gravity values, and free air gravity (in parentheses). Station 22 includes observed gravity
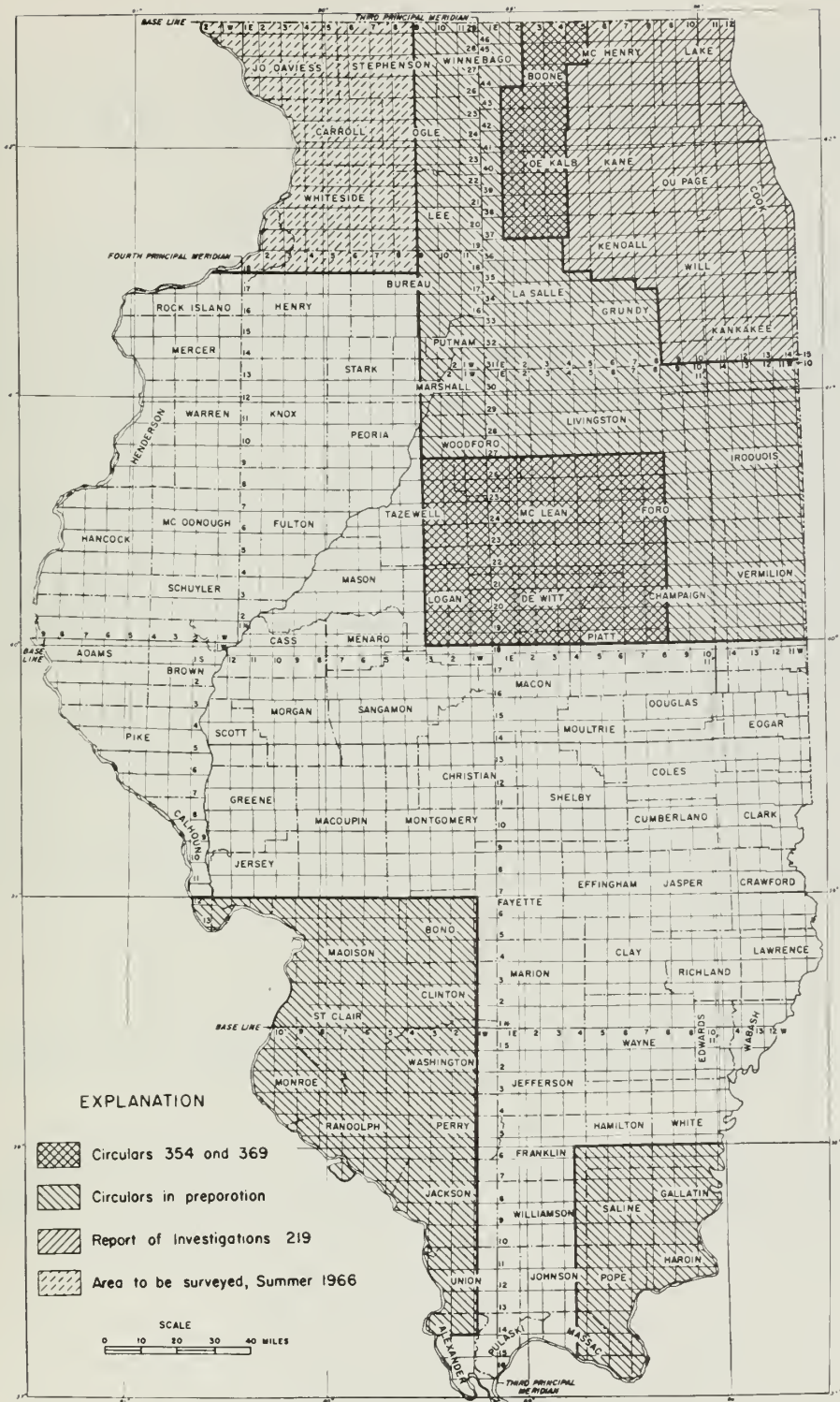at both the pendulum base (a) and the auxillary site (b).

Figure 2. Completed regional gravity surveys in Illinois with one-mile grid coverage.

whereas the range observed in Illinois is only 430 milligals. The meter has a linear variation in scale constant as is shown in figure 4. It was calibrated twice prior to the survey with a small, but negligible, change in scale constant.

SURVEY PROCEDURE AND RESULTS

The gravity network is tied to a pendulum base station, which was established by University of Wisconsin geophysicists, in Room 2, Wilson Hall, 2.3 meters east of the west wall, 1.0 meters north of the south wall, Washington University, St. Louis, Missouri. The observed gravity at the pendulum site is 979.99863 cm sec^{-2} (gals). An auxiliary site at the east entrance to Wilson Hall was established with a gravity meter for convenience of reoccupation. Observed gravity at the auxiliary site is 979.99872 gals (Emil Mateker, Washington University, personal communication).

Stations of the network in Illinois were located mainly at U.S. Geological Survey bench marks with the majority of the sites in cities or towns. Field data for the survey are shown in table 1. The number of ties between stations, and errors and corrections applied to the ties, are shown in table 2. Loops of stations ranged from three stations about thirty miles apart to a large loop circling the state (table 3 and fig. 5). Errors of closure (E_c) around the loops ranged from .000 milligals for the loop (11-9-8-11) to +.385 milligals for the loop (26-22-12-11-8-3-4-6-10-13-17-20-21-23-24-25-26).

Assuming corrections for earth tides (Goguel, 1964) and meter drift (fig. 3) have been accounted for, the error of closure is due to set-up error; thus, the accuracy of a tie between two stations is independent of distance between them and is also independent of the time interval between readings.

Gravity ties between stations around a loop must be adjusted according to the reliability of the ties so that closure equals zero. The accuracy of a tie between two stations is related directly to the number of times the tie was established (N). Thus the error of closure (E_c) is

$$E_c = N_1 C_1 + N_2 C_2 + N_3 C_3 + N_4 C_4 + \ldots \ldots + N_n C_n \qquad (1)$$

where N_n is the number of times a tie was established and C_n is that fraction of the error of closure assigned to ties established N_n times. The fractions of the error of closure weighted between stations are related as

$$C_1 = 2C_2 = 3C_3 = 4C_4 \qquad (2)$$

and so on. An example of the method used to adjust ties is described below.

In the loop, (18-14-12-18) E_c is -.024 milligals. In figure 5, it is seen that two of the ties were established with only one reading, whereas the third tie was established with two readings. Equation 1 may be written then as

$$-.024 = 2C_1 + 1C_2 = \frac{5C_1}{2} . \qquad (3)$$
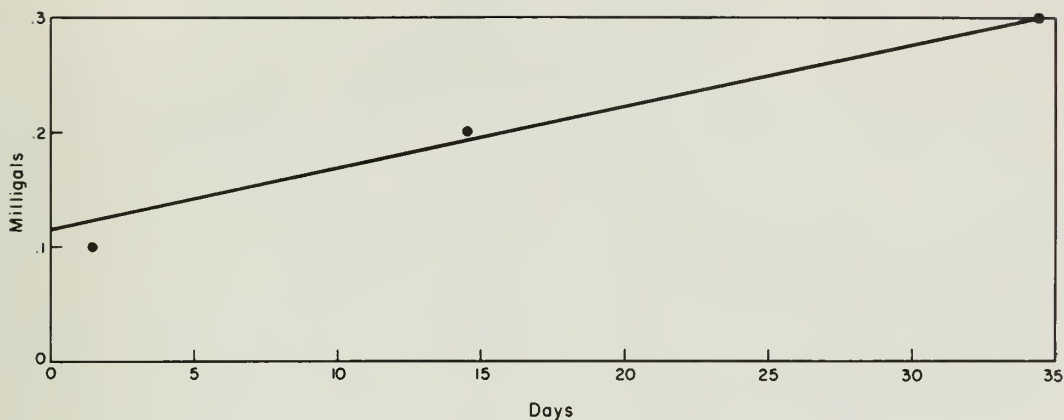
Figure 3. Meter drift (+ .2 milligals/month) during the month of August, 1966.
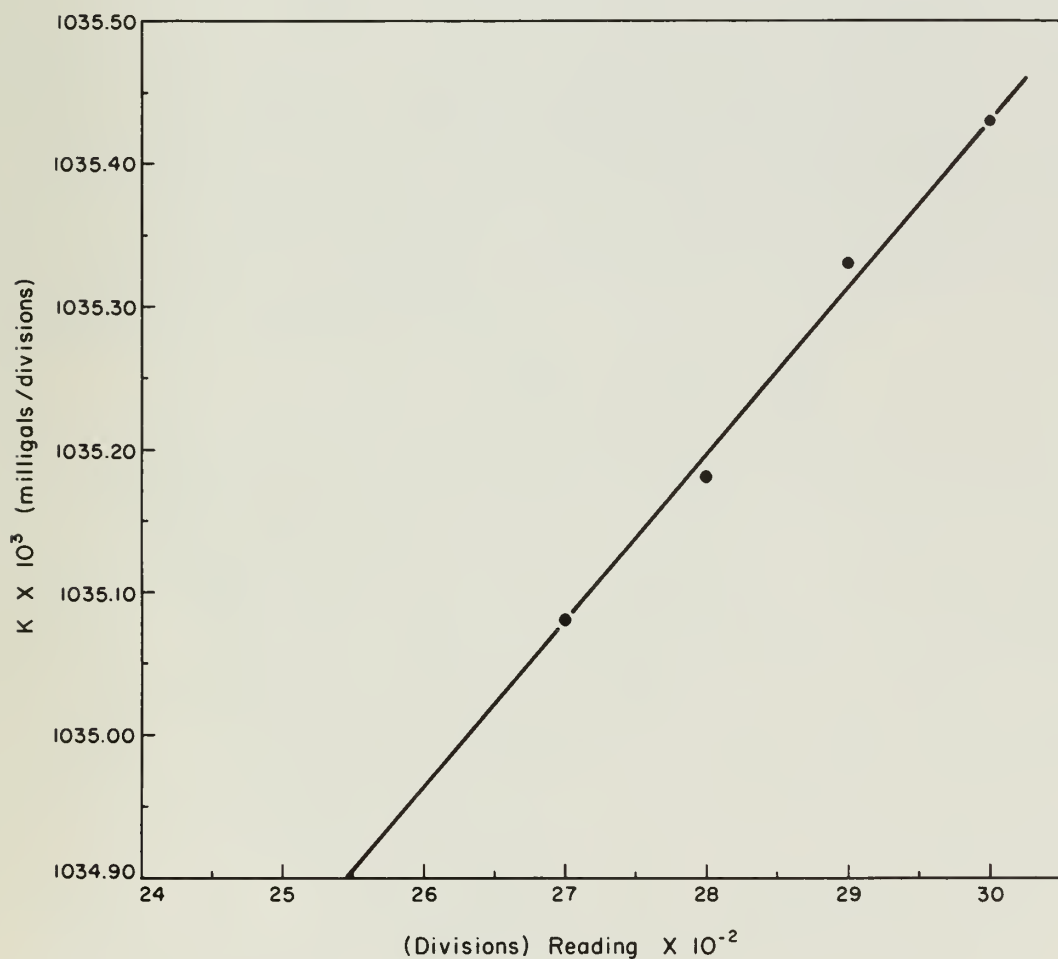

Figure 4. Linear variation of scale constant. Variation of K for LaCoste Romberg G-4 gravity meter.
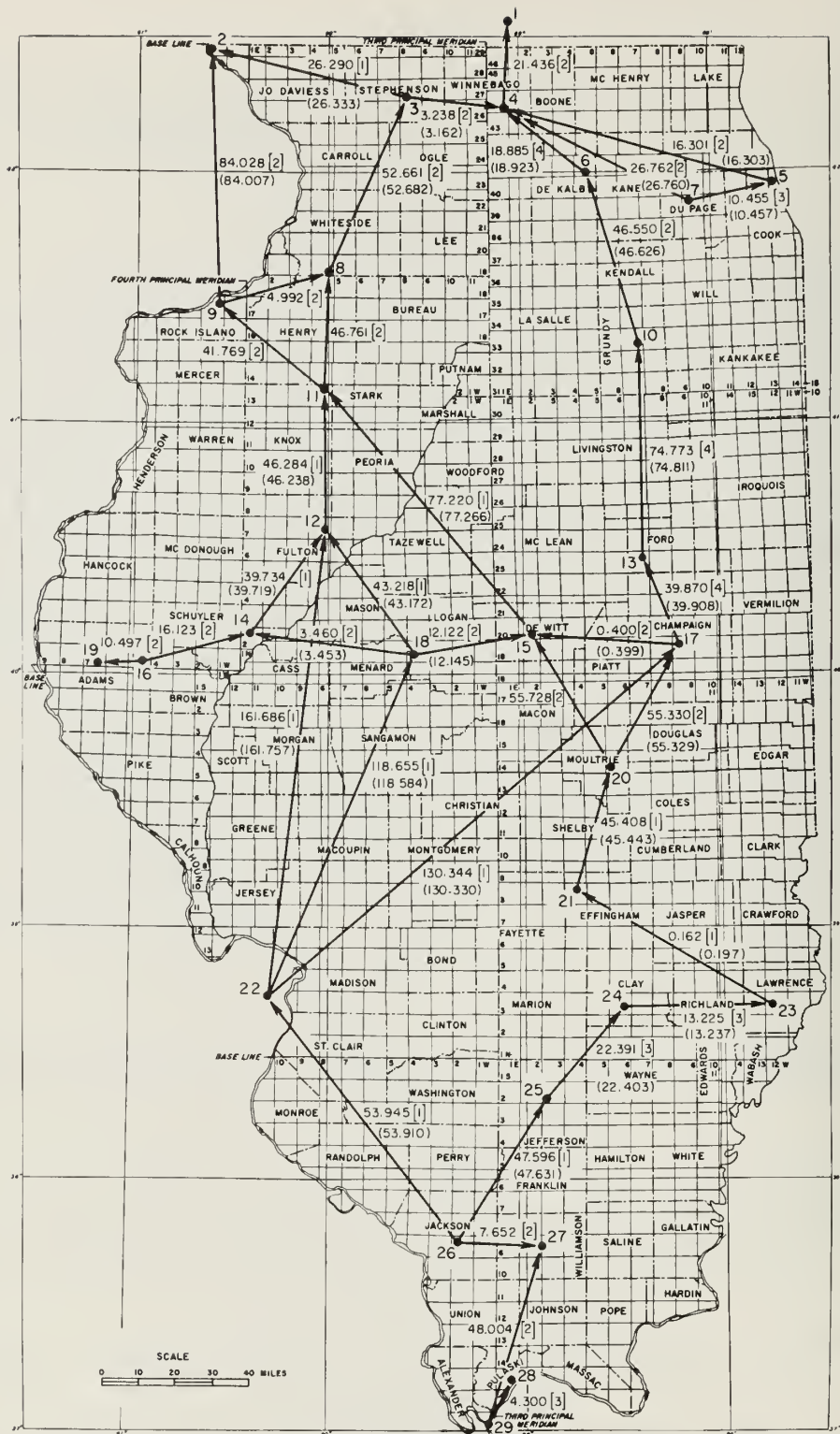
Figure 5. Station locations illustrating mean ties, number of ties—in brackets, and adjusted mean tie around gravity loops—in parentheses. Arrow indicates the direction of increasing potential field.

$C_1 = -.0096$ milligals and $C_2 = -.0048$ milligals. Applying these corrections first to the small loops and then to progressively larger ones and assuming those loops already adjusted to be correct, the closure around all loops is adjusted to zero. Observed mean ties and adjusted (in parentheses) ties between stations are shown in figure 5. The numbers (in brackets) that follow the observed mean tie indicate the number of ties used to establish the mean tie. Adjustments ranged from 0.000 milligals to 0.076 milligals.

Observed gravity values adjusted to the base at Washington University (Station 22), St. Louis, are shown on figure 1. It was found that Station WA175, Janesville-Beloit (Behrendt and Woollard, 1961), which is Station 1 in the present network, had a value of 980.33076 milligals or about 0.5 milligals greater than the Behrendt-Woollard value. The reason for this great a discrepancy is not known, and the respective accuracies of the two base readings cannot be determined from data available. The maximum adjustment required to close a loop was ±.076 milligals.

The network was also tied (Station 26) to U. S. Coast and Geodetic Survey Station number 1110 reported for Murphysboro in 1941. Station 26 was found to be approximately 2 milligals less than the U.S.C.G.S. value. Behrendt and Woollard (1961) reported that much of the U.S.C.G.S. network was in error by over 3 milligals, and it is concluded that the value determined for the present survey is more nearly correct.

Principal facts, latitude, longitude, elevations of bench marks and the gravity meter, observed gravity, Bouguer gravity ($\rho = 2.35$ and $\rho = 2.67$ gm/cm^3), and free air gravity are listed in table 4. Densities of 2.35 and 2.67 gm/cm^3 are both used in calculation of Bouguer anomalies. In areas covered with glacial drift, the density 2.35 gm/cm^3 is used; whereas, in nondrift areas, 2.67 gm/cm^3 is assumed to be a representative density.

ACCURACY OF READINGS

The gravity network was tied to the St. Louis pendulum base station at which an absolute value for the earth's gravitational field was determined. The remainder of the stations in the network were, as stated previously, established with a gravity meter and, therefore, observed gravity at these stations is based on gravity differences. The relative accuracy of each station is thus a function of the accuracy of the St. Louis base and also a function of errors involved in the reading and setting up of a station and in the calibration of the gravity meter. Meter calibration by members of the U. S. Army Map Service was carried out prior to the establishment of the base network.

If the calibration of the meter and the gravity value at the pendulum site are assumed to be correct, the accuracies of the observed gravity values in the network are a function only of set-up accuracy. A tie between two stations thus involves two possibilities for error. An estimate of the limits of possible error follows.

As the number of ties between two stations increases, the probability that the mean of the gravity differences ($\overline{\Delta g}$) represents the true difference (Δg_t) also increases. Seven of the 38 ties have been tied three or four times, and the averages of these represent the closest approximation to true gravity differences in the network. Ties should have a normal distribution about the true tie in the manner shown in figure 6.

Figure 6. Expected normal distribution of ties about a true gravity tie.
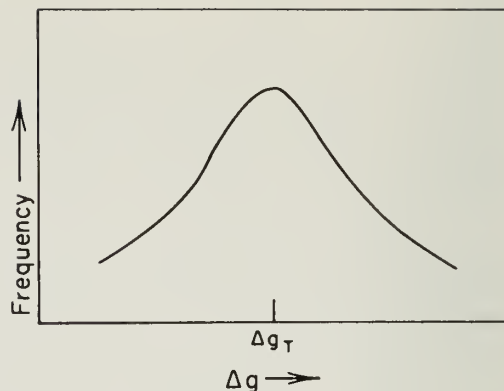
The true gravity difference (Δg_t) between any two stations is unknown in the present survey. It may be approximated only by the normal distribution pattern about a sample mean $(\overline{\Delta g})$. The distribution of ties about sample means (derived from the seven ties having three or more total ties) is illustrated in figure 7. A normal distribution is apparent, having a standard deviation of ±0.047 milligals. The 99 percent confidence limit for the above data is ±.108 milligals, which is greater than the maximum adjustments applied to any tie. The fact that the error of closure around the largest loop (760 miles) in the state, comprising 16 ties, was only .385 milligals is evidence that errors are well within the limits described above. Because of the small error of closure, it is believed that, after adjustments, all base stations in the state are tied to within ±0.1 milligals of the St. Louis base.
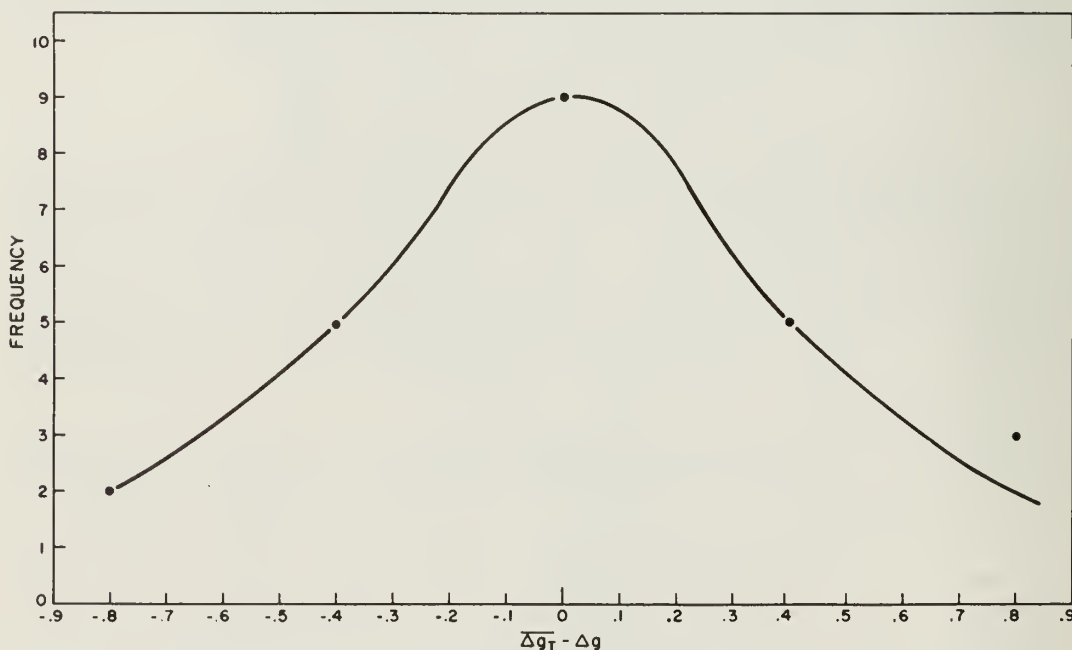
Figure 7. The normal distribution of ties about a mean Δg. Four-tenths of a milligal frequency interval is utilized in order to produce a smoothed curve.

CONCLUSIONS

Gravity surveys in Illinois may be tied now to a common base station network of high precision. Incorporation of this data into a worldwide system is made easier. Interpretations of the geology in the state based on gravity data is facilitated also by the use of a common system. Regional published surveys and all surveys to be published in the future by members of the Illinois Geological Survey will be adjusted to this network.

TABLE 1. GRAVITY BASE STATION NETWORK
FIELD DATA, UNCORRECTED FOR METER DRIFT OR EARTH TIDES

1965 Month	Time	Counter reading	Station no.	1965 Month	Time	Counter reading	Station no.
April				August			
27	2:20 PM	2756.528	17	25	9:00 AM	2621.914	21
	3:20	2794.980	13		10:14	2665.732	20
	4:20	2756.520	17		11:36	2719.203	17
28	9:29 AM	2756.403	17		2:00 PM	2719.228	17
	10:29	2794.948	13		2:51	2719.631	15
	10:35	2794.850	13		3:49	2707.972	18
	11:58	2867.039	10		5:14	2711.345	14
	1:10 PM	2794.771	13		6:16	2695.841	16
	2:47	2867.068	10		7:42	2705.973	19
	4:20	2912.072	6	26	8:58 AM	2705.925	19
	5:28	2930.289	4		9:16	2695.755	16
	7:43	2912.019	6		10:10	2711.312	14
	8:32	2930.250	4		11:03	2749.645	12
29	10:31 AM	2930.130	4		12:45 PM	2707.845	18
	11:32	2950.835	1	September			
	12:26 PM	2930.124	4	6	8:40 AM	2593.340	22
	1:37	2911.902	6		2:50 PM	2749.594	12
	3:10	2866.991	10		4:03	2794.339	11
	4:21	2794.778	13		6:00	2839.550	8
	5:20	2756.209	17		8:10	2834.744	9
August (Daylight Saving)					10:15	2915.928	2
19	2:03 PM	2719.342	17	7	9:20 AM	2915.658	2
23	9:48 AM	2593.254	22		10:50	2890.222	3
	12:34 PM	2541.164	26		11:45	2893.337	4
	2:00	2548.596	27		2:40 PM	2877.690	5
	4:07	2502.338	29		3:45	2867.658	7
	4:46	2506.489	28		4:55	2877.780	5
	5:16	2502.336	29		6:15	2867.661	7
	5:42	2506.511	28		7:40	2893.532	4
	6:34	2548.778	27		9:15	2890.378	3
	8:28	2541.359	26	8	9:45 AM	2839.375	8
24	9:52 AM	2587.142	25		10:37	2834.494	9
	12:20 PM	2608.802	24		11:40	2794.180	11
	1:37	2621.633	23		2:08 PM	2719.620	15
	2:24	2608.924	24		3:20	2665.861	20
	3:25	2587.352	25		4:45	2719.324	17
	4:33	2609.048	24				
	5:24	2621.902	23				
	7:19	2622.092	21				

TABLE 2. TIES BETWEEN INDIVIDUAL GRAVITY BASE STATIONS

Tie	Total ties	Δg min milligals	Δg max milligals	Δg min – Δg max milligals	Mean Δg milligals	Adjusted mean Δg milligals
17-13	4	39.789	39.945	.156	+ 39.870	+ 39.908
13-10	4	74.697	74.824	.127	+ 74.773	+ 74.811
10-6	2	46.532	46.568	.036	+ 46.550	+ 46.626
6-4	4	18.841	18.936	.095	+ 18.885	+ 18.923
4-1	2	21.427	21.444	.017	+ 21.436	---
17-22	1				-130.344	-130.330
22-26	1				- 53.945	- 53.910
26-27	2	7.641	7.663	.022	+ 7.652	---
27-29	2	47.966	48.041	.075	- 48.004	---
29-28	3	4.281	4.318	.037	+ 4.300	---
26-25	1				+ 47.596	+ 47.631
25-24	3	22.350	22.442	.092	+ 22.391	+ 22.403
24-23	3	13.153	13.303	.150	+ 13.225	+ 13.237
23-21	1				+ 0.162	+ 0.197
21-20	1				+ 45.408	+ 45.443
20-17	2	55.248	55.412	.164	+ 55.330	+ 55.329
17-15	2	.367	.432	.065	+ 0.400	+ 0.399
15-18	2	12.120	12.123	.003	- 12.122	- 12.145
18-14	2	3.436	3.484	.048	+ 3.460	+ 3.453
14-16	2	16.087	16.158	.071	- 16.123	---
16-19	2	10.467	10.526	.059	+ 10.497	---
14-12	1				+ 39.734	+ 39.719
12-18	1				- 43.218	- 43.172
18-22	1				-118.655	-118.584
22-12	1				+161.686	+161.757
12-11	1				+ 46.284	+ 46.238
11-8	2	46.757	46.764	.007	+ 46.761	+ 46.761
8-9	2	4.955	5.028	.063	- 4.992	- 4.992
9-2	2	83.977	84.079	.102	+ 84.028	+ 84.007
2-3	1				- 26.290	- 26.333
3-4	2	3.225	3.250	.025	+ 3.238	+ 3.162
4-5	2	16.294	16.308	.014	- 16.301	- 16.303
5-7	3	10.426	10.496	.070	- 10.455	- 10.457
7-4	2	26.720	26.804	.084	+ 26.762	+ 26.760
3-8	2	52.655	52.666	.011	- 52.661	- 52.682
9-11	2	41.729	41.809	.080	- 41.769	- 41.769
11-15	1				- 77.220	- 77.266
15-20	2	55.680	55.775	.095	- 55.728	- 55.728

TABLE 3.   INTERNAL CONSISTENCY OF GRAVITY BASE STATION NETWORK

Loop no.	Station nos.	Error of closure (milligals)
(1)	7- 5- 4- 7	-.006
(2)	20-17-15-20	+.002
(3)	18-15-11-12-18	-.160
(4)	18-14-12-18	-.024
(5)	11- 9- 8-11	.000
(6)	9- 8- 3- 2- 9	-.085
(7)	17-13-10- 6- 4- 3- 8-11-15-17	-.202
(8)	22-18-12-22	+.187
(9)	22-18-15-17-22	+.033
(10)	26-22-17-20-21-23-24-25-26	+.177
(11)	26-22-18-15-20-21-23-24-25-26	+.212
(12)	22-17-15-18-12-22	+.154
(13)	18-12-11- 8- 3- 4- 6-10-13-17-15-18	+.362
(14)	26-22-12-11- 8- 3- 4- 6-10-13-17-20-21-23-24-25-26	+.385

TABLE 4. GRAVITY BASE STATION NETWORK IN ILLINOIS

State	County	Station no.	Quadrangle	Latitude	Longitude	Elevation Bench mark	Elevation Meter	Gals (observed)	Bouguer milligals 2.35 gm/cc	Bouguer milligals 2.67 gm/cc	Free air milligals	Location of station
Wisconsin	Rock	1	Janesville	42°37.1'	89°02.0'	807	807.0	980.33076	-32.1	-35.4	- 7.9	East side of gate at Rock County Airport
Illinois	Jo Daviess	2	East Dubuque	42°28.8'	90°37.4'	611.7	611.7	980.33249	-30.5	-33.0	-12.1	USGS BM "611" East Dubuque, in NE/c or intersection of Wisconsin and Sinsinawa Aves., in SW/c or yard of City Hall, in concrete post stand. disk
Illinois	Stephenson	3	Freeport	42°17.9'	89°37.2'	780.1	780.4	980.30616	-29.7	-32.9	- 6.3	USGS BM "1915" - 781" Freeport, at south entrance of post office in west end of top granite step. Standard tablet
Illinois	Winnebago	4	Camp Grant	42°14.7'	89°05.2'	735.0	733.5	980.30932	-24.7	-27.7	- 2.7	USGS R 222 in Rockford. At the T-intersection of Kishwaukee St. and 21st Ave., in S-35, R-1E, T44N, 29 ft. W of the W curb of Kishwaukee St., 67 ft. S of prolonged center line of 21st Ave., set vertically in south face of the concrete foundation of one-story red brick building housing the Damascus Steel Prod. Corp., 2½ ft. W of SE/c of the bldg., 1½ ft. above grd. level (735.016) standard disk
Illinois	Cook	5	Chicago Loop					980.29302				At administration bldg. of U. of I. Chicago off Morgan St., on SE/c of concrete plaza surrounding the bldg; at NE/c of parking lot; 18.5 in. W of brick wall on E side of parking lot; 8.5 in. N of N concrete curbing bordering gravel area at base of brick wall; directly south of SE pillar of admin. bldg.; chiseled cross
Illinois	DeKalb	6	Sycamore	41°59.1'	88°39.9'	835.1	835.1	980.29040	-13.8	-17.2	+11.3	Sycamore, 1.1 mi. E of, near center of SE¼ sec. 33, T41N, R5E, 0.3 mi. W of junction of T-road S, 1 ft. W of E end of S headwall of concrete culvert under highway; chiseled square (835.11)

TABLE 4. CONTINUED

State	County	Quadrangle	Station no.	Latitude	Longitude	Elevation		Gravity Readings				Location of station
						Bench mark	Meter	Gals (observed)	Bouguer milligals		Free air milligals	
									2.35 gm/cc	2.67 gm/cc		
Illinois	DuPage	Wheaton	7	41°51.8'	88°06.2'	752.5	749.5	980.28256	-16.2	-19.2	+ 6.3	Wheaton, at DuPage County courthouse on N side of W W entrance was alum. tablet "1905 753" (752.536)
Illinois	Whiteside	Erie	8	41°35.0'	90°00.7'	617.6	617.6	980.25347	-28.6	-31.2	-10.1	T19N, R4E, about 0.25 mi. W of S¼c sec. 35 at Arnett school, 30 ft. N and 10 ft. W from junction of T-road S at N/c Secs. 2 and 3, T18N, R4E, in concrete post; standard tablet stamped "TT Sta. No. 123 JLS 1927". Elev. 617.642
Illinois	Rock Island	Milan	9	41°28.9'	90°35.2'	594.6	594.6	980.24848	-26.0	-28.4	- 8.2	Milan, 2.4 mi. NW of, in South Rock Island, on W side of Ninth Str., 300 ft. W of school no. 1 (District 2), 4 ft. E of plank fence, just S. of line of junction with center of street leading E to central street car sta.; standard iron post with bronze cap stamped "596" and "Prim. Trav. Sta. no. 42 1910" Elev. 594.637
Illinois	Grundy	Morris	10	41°19.5'	88°24.0'	549.4	548.4	980.24377	-19.7	-21.9	- 3.2	Morris, 2.2 mi. S and 1.0 mi. E from, 0.25 mi. S of NW/c Sec. 23, T33N, R7E, in SE angle of road junction, on S side of E-W road, 2 ft. N of fence; standard iron post with bronze cap stamped "550". Elev. 549.377
Illinois	Knox	Galva	11	41°08.1'	90°02.5'	819.7	819.5	980.20671	-22.4	-25.7	+ 2.2	Galva, 2.0 mi. S of, at Potter sch., near SW/c Sec. 3, T. 13N, R. 4E, 30 ft. N and 47 ft. E from X roads, 20 ft. E of SW/c of plank fence around school yard, in concrete post; stand. tab. "Prim. Trav. Sta. No. 134 K 1924" (819.710) (No school - now cornfield - BM still there inside corner of wire fence)
Illinois	Fulton	Canton	12	40°33.2'	90°02.2'	653.9	654.2	980.16047	-27.2	-29.9	- 7.6	Canton, at High School Bldg., S of main entrance facing east, between S door and pillar in top

TABLE 4. CONTINUED

State	County	Quadrangle	Station no.	Latitude	Longitude	Elevation Bench mark	Elevation Meter	Gals (observed)	Bouguer milligals 2.35 gm/cc	Bouguer milligals 2.67 gm/cc	Free air milligals	Location of station
Illinois	Fulton	Canton, continued										step; alum. tab. USGS "655" 1909 (653.880)
Illinois	Ford	Gibson City	13	40°29.4'	88°22.8'	767.8	766.8	980.16896	– 5.9	– 9.0	+17.0	Gibson City 1.8 mi. S along the Wabash Railway from the station at Garber, Ford Co., 17 poles S of milepost 111, 45 ft. W of the centerline of the track at railroad culvert 1304, 3-½ poles north of a private-road crossing, in the center of the top of the E concrete headwall of a 2- by 2-foot highway culvert, 18 ft. E of the centerline of State Highway 47, and about 3 ft. lower than the track. Standard disk, stamped "F 22 1934" (767.813)
Illinois	Schulyer	Beardstown	14	40°10.4'	90°22.1'	616.1	616.6	980.12075	–35.6	–38.1	–17.0	Bader, on S side of -J., in line with rd. N, 150 ft. SW of store bldg. in concrete post; stand. tablet USC and GS "14 S 1923" (616.088)
Illinois	DeWitt	Maroa	15	40°09.2'	88°53.4'	715.3	715.2	980.12945	–17.3	–20.2	+ 4.1	Clinton, 3.5 mi. E of along St. Highway 10. 100 ft. E of drain under highway; 59 ft. S of center of highway; 3 ft. N of fence line; in a concrete post; a standard tablet stamped "TT16 RE 1956".
Illinois	Adams	Augusta	16	40°01.9'	99°57.8'	720.8	720.0	980.10463	–32.5	–35.4	–10.8	Clayton, in NE/c of School yd., 15 ft. N of 18 in. elm tree USGS BM stand. iron post with bronze cap (720.842)
Illinois	Champaign	Urbana	17	40°06.0'	88°13.9'	751.2	751.5	980.12905	–12.1	–15.1	+10.4	About 10 ft. from the SE/c of Sixth and Peabody, and about 20 ft. from the NW/c of Natural Resources Bldg in Urbana. U. of I. Bench Mark #12.
Illinois	Logan	Mason City	18	40°06.0'	89°35.5'	583.7	584.2	980.11730	–34.6	–37.0	–17.0	Middletown, near center of public park at center of town, on top of NE/c of concrete foundation for cannon; chiseled sq. (583.73)
Illinois	Adams	Camp Point	19	40°01.3'	91°12.3'	742.2	741.0	980.11513	–19.7	–22.8	+ 2.5	Paloma, at W end of town, 0.3 mi. W of RR station at jct. of T road from S, 150 ft. N of US hwy 24 and from

TABLE 4. CONTINUED

State	County	Quadrangle	Station no.	Latitude	Longitude	Elevation Bench mark	Elevation Meter	Gals (observed)	Bouguer milligals 2.35 gm/cc	Bouguer milligals 2.67 gm/cc	Free air milligals	Location of station
Illinois	Adams	Camp Point, continued										200 ft. N of RR tracks, in SW/c, 35 ft. S and 15 ft. W of jct. USGS BM labeled "743" standard iron post with bronze cap
Illinois	Moultrie	Sullivan	20	39°37.6'	88°34.0'	648.1	648.2	980.07372	-32.0	-34.7	-12.6	Sullivan, 1.7 mi. N and 2.3 mi. E from, at Twomile school, .25 mi. N of SE/c sec. 30, T14N, R6E, 24 ft. N and 4 ft. W from cross-roads, in SE/c of school yd, in concrete post, standard tablet stamped "TT sta. No. 28 E 1929"
Illinois	Effingham	St. Elmo	21	39°08.8'	88°45.5'	613.1	613.6	980.02828	-37.3	-39.8	-18.9	Moccasin, at town hall, on SE/c of concrete porch; sq. cut (B & O RR BM) (613.12)
Missouri	St. Louis		22	38°38.8'	90°18.4'			979.99872				Washington Univ. in St. Louis, Mo., East door of Wilson Hall.
Illinois	Lawrence	Sumner	23	38°42.3'	87°45.6'	446.2	444.5	980.02808	- 9.3	-11.1	+ 4.0	Bridgeport, at B & O RR sta., 2 ft. S of NE/c of sta.; about 20 in. above grd. in E face of concrete foundation, set vertically standard disk USC & GS "N 127 1938" (446.167)
Illinois	Clay	Flora	24	38°40.0'	88°29.3'	496.4	496.9	980.01484	-15.8	-17.8	- 0.9	Flora, at Baltimore & Ohio RR sta.-at SW/c of platform. Steel pin in W curbing 160 in. from northernmost track. Elev. 496.86 ft. from top of pin - at least 40 yrs. old elev. written on curbing
Illinois	Jefferson	Mt. Vernon	25	38°19.0'	88°54.2'	515.4	515.6	979.99244	- 6.3	- 8.3	+ 9.2	Mt. Vernon post office in W end of top step of front entrance of bldg., standard tablet USGS BM "516 G" (515.399)
Illinois	Jackson	Murphysboro	26	37°46.0'	89°20.7'	416.7	416.7	979.94481	-12.1	-13.8	+ 0.4	Murphysboro (USCGS Pendulum Sta.) Located on the Gulf, Mobile, & Ohio RR prop., at the NE/c of 19th and Logan Sts., in the W central sec. of the city of Murphysboro. From post office in Murphysboro, go 0.3 mi. W along Walnut St. thence 0.2 mi. N along 19th St. to Logan St. A stand. grav. ref. stamped "Murphysboro 1941" is on top of

TABLE 4. CONTINUED

State	County	Quadrangle	Station no.	Latitude	Longitude	Elevation		Gravity Readings				Location of station
						Bench mark	Meter	Gals (observed)	Bouguer milligals 2.35 gm/cc	2.67 gm/cc	Free air milligals	
Illinois	Jackson	Murphysboro, continued										concrete post, flush with surface of ground. It is 67 ft. E from center line of 19th st., 60 ft. N from centerline of Logan St., and 509 ft. W from most westerly rail of the Gulf, Mobile & Ohio RR tracks
Illinois	Williamson	Marion	27	37°43.9'	88°55.6'	448.5	448.9	979.95245	+ 0.7	- 1.2	+14.1	At Marion, at courthouse, 24 ft. NE of SE/c of Courthouse, 6 ft. normal and on W side of concrete curb; 5 ft. normal and on E side of E edge of sidewalk, 8 ft. SSE of 16 in elm tree, on top of concrete post, standard disk "J 120 1935" (448.460)
Illinois	Pulaski	Cairo	28	37°10.8'	89°05.2'	441.4	441.4	979.90875	+ 4.5	+ 2.7	+17.7	Olmsted, 0.6 mi. SE of, 2.9 mi. SW of Levings, 0.6 mi. NW of Caledonia Landing, on summit of nill, 175 ft. NE of jct. of T road SE/ 140 ft. SW of jct. of rd. NW, on SE side of road, 35 ft. SW of SW/c of Luth. Ch.; 11 ft. SE of NW end of fence line between ch. and parsonage on Ne side of fence, in concrete post; standard tablet USGS BM "1927 442" (441.375)
Illinois	Pulaski	Cairo	29	37°00.4'	89°10.6'	317.7	317.7	979.90445	+ 7.3	+ 6.0	+16.8	Cairo BM USG & GS G116 1935 - at SE/c of sq. - at 15th St. and Wash. St. - in front of cannon 1 ft. from NW sidewalk on Wash. (no elev. indicated on BM) 317.680

REFERENCES

Behrendt, J. C. and Woollard, G. P., 1961, An evaluation of the gravity control network in North America: Geophysics, v. 26, no. 1, p. 57-76.

Goguel, Jean, 1964, Tidal gravity corrections for 1965: Geophysical Prospecting (European Assoc. of Exploration Geophysicists), v. XII, supp. 1, 53 p.

Heigold, P. C., McGinnis, L. D. and Howard, R. H., 1964, Geologic significance of the gravity field in the DeWitt-McLean County area, Illinois: Ill. Geol. Survey Circ. 369, 16 p.

McGinnis, L. D., 1966, Crustal tectonics and Precambrian basement in northeastern Illinois: Illinois Geol. Survey Rept. Inv. 219, 29 p.

McGinnis, L. D., Kempton, J. P. and Heigold, P. C., 1963, Relationship of gravity anomalies to a drift-filled bedrock valley system in northern Illinois: Ill. Geol. Survey Circ. 354, 23 p.